Saving Money and the Environment Through Energy Efficiency

Options for
Wastewater Treatment Facilities

Energy Effecient

Savings

COST

March 2001

ACKNOWLEDGEMENTS

EPA would like to thank the following people and organizations for their assistance and valuable contribution to this report.

George Neill, New Hampshire Department of Environmental Services
Brian Hilliard, New Hampshire Department of Environmental Services
Dick Darling, Maine Department of Environmental Protection
Don Albert, Maine Department of Environmental Protection
Joe Dupuis, Massachusetts Department of Environmental Protection
Alex Pinto, Rhode Island Department of Environmental Management
Steve Bolles, Woodard and Curran Consulting Engineers
Jim Rogers, Energy Consulting
Ed Ting, Toshiba International Corporation
Fred Goguen, Stultz Electric Motor Systems
Larry Palow, Central Maine Power Company
Donna Keeley, Public Service of New Hampshire
Bill Ralph, Green Mountain Power Service
Kirk Laflin, New England Interstate Water Pollution Control Commission
Chuck Conway, New England Interstate Water Pollution Control Commission
Bonneville Power Administration
Hydraulic Institute
U.S. Department of Energy

Table of Contents

SAVE MONEY AND THE ENVIRONMENT THROUGH ENERGY EFFICIENCY

Executive Summary

Energy use can account for up to one third of the operating budget of a wastewater treatment facility. Energy use is also closely linked to environmental impacts and contribute to environmental problems that are felt locally, regionally, and globally. For example, for every 100 kilowatt-hours of energy generated from carbon-based fuels, nearly 130 pounds of pollutants are discharged.

Many of the older treatment plants in New England were designed at a time when energy conservation was not an issue - energy was inexpensive and considered relatively inexhaustible. Treatment facilities built in the 1970's and 80s are likely at or near their design life and will soon be in need of repair, upgrade or replacement. An ideal time to evaluate and improve your energy management practices is when repairing or upgrading your facility.

This document is part of a cooperative initiative among EPA-New England, the New England states, and the New England Interstate Water Pollution Control Commission to help educate municipal facilities about energy management and options. It provides information about the opportunities for municipal wastewater treatment facilities to better understand their energy use. It also discusses ways to improve efficiency, which can lead to reduced costs and fewer environmental impacts. This initiative also includes energy management workshops to be held in each of the six New England states and preliminary energy assessments of five New England treatment facilities that are included in **Appendix E**.

Introduction

Human activities rely on the combustion of carbon based fuels for energy, which in turn has an important impact on our environment. Such combustion unavoidably results in byproducts that are released, primarily into the atmosphere, where they accumulate. There are over five hundred wastewater treatment facilities in New England with the potential to prevent hundreds of tons of air pollutants and save tens of thousands of dollars each year. By evaluating your wastewater system, you may be able to reduce your energy costs and help the environment.

This document outlines the major areas where a facility may find opportunities to better manage the use of energy. Evaluating a treatment system to increase efficiency and reduce costs can be segmented into the following areas:

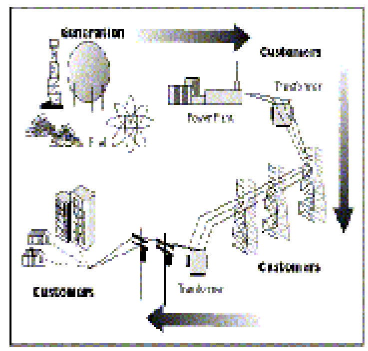
* Energy Costs and Utility Rate Structure
* Pump System Efficiency
* Mechanical Efficiency
* Electrical Efficiency

Many commercial and industrial facilities have benefitted financially by making energy improvements. Municipalities can also benefit from improved energy management and help the environment.

Utility Industry

Your Choice of Electricity

Restructuring of the electric utility industry, sometimes called deregulation, is the separation or unbundling of charges for energy generation and transmission/distribution. Restructuring also transfers the control of ***energy generation*** from the government regulators to the free market. Simply put, under restructuring, the customer can choose which company will produce their electricity. The delivery of electricity will continue to be provided by the distribution company, formerly the companies that provided all the electric service.



You can now choose a new supplier or you can do nothing, receive the Standard Offer and choose when you are ready. The choices you have include:

* Choose an Electricity Supplier
* Join a Buying Group
* Receive Standard Offer Service

Customers may shop around for electricity supply based on:

* price
* terms of contract
* customer service options
* mix of renewable and non-renewable
* energy sources

Electric restructuring is an important issue for New England, since we have some of the highest electric rates in the country. While there are no guarantees, a fully competitive market should, over time, help to lower the overall electric rates so they are closer to the national average.

With restructuring, consumers can have a direct positive effect on the environment. That's because consumers have the option to choose suppliers with power plans that include more renewable energy in their power mix. Renewable energy typically costs more to produce, but with more consumer support, the costs of renewable power should go down. You can affect the availability and affordability of renewable energy by choosing an energy supplier who is more environmentally responsible.

Group Buying

Buying groups, sometimes known as aggregates, enter purchasing agreements with electricity suppliers at favorable rates or terms for their members. Group buying can give a facility the buying clout of a larger consumer and may receive advantages as discounted prices, special billing services, or power from preferred sources- such as renewable power. The supplier benefits by having a ready made group of consumers ,which reduces marketing costs, and having a predicable customer load which lessens their risk.

Joining a buying group means entering into a business relationship with the rest of the group. As with any business arrangement, a facility must look carefully at the group's make-up, financial viability and goals. For further information on utility restructuring or group buying contact your state Public Utilities Commission (Appendix A).

Evaluate Your Costs

Understanding your utility bills, present and future, and how charges are assessed is also essential to your strategy to reduce your energy costs. In fact, most bills include two, three or four separate charges. While your utility bill indicates how much energy and power you used, the rate structure is the guide for determining how costs are allocated. Ask your electric utility and energy suppliers for a printed rate schedules that describe the various rates available and illustrate how charges are calculated. Most utilities are willing to change a customers rate schedule free of charge, providing you qualify for the new rate. **Appendix B** explains further about understanding your utility bill.

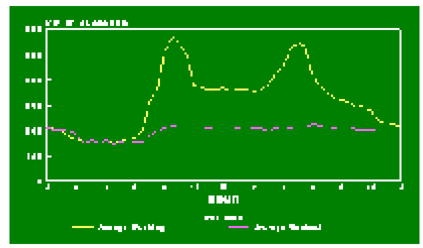
Conduct an Energy Assessment

To better understand where your energy is being used and what improvements can be made, conduct an energy assessment of your facility . An energy assessment can: identify where energy is wasted; help develop an energy purchasing strategy; provide a baseline for tracking energy use; and provide a basis for an action plan (see **Appendix C).**

Determining your current electricity costs in a meaningful measure, such as dollars per million gallons treated, can be useful. This allows you to establish a baseline operating cost against which to measure improvements as well as compare to other facility operating costs. It is also a useful tool when explaining energy or cost issues.

In general, restructuring should result in lower rates for consumers. Like all consumers, municipal facilities will be in a much better position if they understand how they use energy and are informed about the changes occurring in their state.   Your current utility and state utilities commission are able to advise you on how restructuring may affect you (see **Appendix A**). If you choose to do nothing, your utility, or a utility appointed by the utilities commission, will continue to provide you with reliable power. However, we encourage you to take the time to investigate the options available to you through the restructuring of the industry.

Utility Assistance Programs

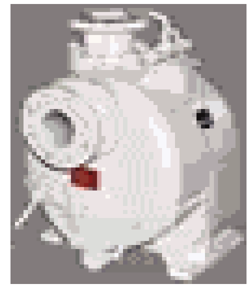


Electric utility Demand Side Management (DSM) refers to programs implemented by utilities to help customers focus on energy conservation and energy management techniques. The customer benefits by managing their energy needs better and lowering their costs; the utility benefits because it helps defer the need for new sources of power; and the environment benefits by reduced air emissions. These benefits are primarily accomplished through efficiency programs that reduce overall energy use, and peak load (energy use) reduction programs, that focus on reducing energy use during periods of high consumption. If you have not already done so, assess the benefits of boosting efficiency and adjusting energy use to off peak hours to take advantage of lower utility rates.   You may be surprised at how much energy can be saved. **Appendix C** provides some simple strategies for managing your energy demand.

Many utilities will offer a free assessment of your facility's energy practices. Where equipment replacement is recommended, rebates or discounts may be available. Contact your utility account representative for more information on product and services. However, assessments performed by the utilities are usually confined to evaluating the use of energy over an operating day and the efficiency of energy consuming equipment, such as motors.   The utility does not commonly evaluate a facility's treatment options or pumping systems.   Before making improvements to electrical or mechanical equipment, it would be prudent to perform a pumping and aeration system assessment. There are engineering firms and energy service companies that can assess treatment systems as well as energy use and efficiency.

Some facilities may be tempted to wait and see what happens regarding utility restructuring, believing it may affect the economics of planning energy efficiency improvements. Generally, this is not wise. Most energy efficiency improvements have a fast payback time, and any delay in implementing them only causes your facility to continue to spend more than it needs to for energy.

Pumps and Pumping Systems



Each component of a pumping system (pumps, motors, pipes, drives, valves) has an efficiency, which together make-up the overall system efficiency. Because pumping fluids at wastewater treatment plants accounts for most of a facility's energy costs, using pumps efficiently can help minimize those costs. Department of Energy studies indicate that as much as 20% of the energy consumed in pumping can be saved by using pumps more efficiently.

Modern pumps can achieve as high as 90% efficiency when operating in the optimum range. Pumps are designed for the highest efficiency at a specific flow rate and head (elevation) condition. When operated at flow rates that are quite different the efficiency will be reduced. In fact, many pumping systems are not operated at the best efficiency. Although pumps do lose efficiency as they age, the flow requirements of a pumping system may have changed over time and it no longer operates in the best efficiency range.

For example, pump stations that are sized to handle high flows from a combined sewer system, or from groundwater infiltration, may operate inefficiently at normal wastewater flows. If a community has begun separating stormwater or infiltration from its sewer system, thereby reducing the flow, the pump system may no longer operate within their optimum efficiency range. Energy and money are being wasted.

A pumping system has three key elements: flow, static head, and frictional head. Each of these elements must be challenged to find the opportunities for improvements within a pumping system. **Appendix D** provides further tips on improvements to each of these areas. Below is a list of possible opportunities for savings.

* Reduce flow and total head requirements.
* Select the most efficient pump type and size (don't overemphasize the initial cost).
* If throttling flow evaluate the use of VFDs.
* Use two or more smaller pumps instead of one large pump.
* Maintain pumps and all system components to avoid efficiency loss.

In most applications, it costs much more to operate a pump for one year than it does to buy the pump. Considering the high energy costs in New England, a 20% reduction in operating costs can pay for the cost of a pump in about a year. Consider the following example.

A pump station operates 75% of the time at only 60% efficiency. A pumping assessment indicates a new 25 horsepower motor and pump would increase the efficiency to 80%.

New Pump and Motor Cost =	$ 4,500	
Annual Operating Cost at 60% =	$ 20,422	(at $0.10/kWh)
Annual Operating Cost at 80% =	$ 15,316	

Savings = \$ 5,106
Simple Payback = \$ 4500 /\$ 5,106 = 10.5 months

This example uses round numbers, and each situation needs to be evaluated, but the potential savings in energy and cost are considerable. Through a pumping system evaluation you may find opportunities to improve your system and begin saving on energy costs.

Motors: Are energy efficient motors really worth it?

Although the initial cost of an energy efficient motor can be fifteen to thirty percent higher than for a comparable standard motor, the savings usually offset the higher capital cost in two years or less. Because pumps and blower motors account for eighty to ninety percent of the energy costs at wastewater treatment facilities, energy efficient motors can play a major role in reducing a facility's operating costs. The lifetime energy costs to operate a continuous-duty motor are ten to twenty times higher than the original motor price. Use the following formulas to calculate the annual energy savings and simple payback from selecting a more efficient motor. Simple payback is defined as the time required for the savings from an investment to equal the initial cost.

Annual Energy Savings, kWh/yr= hp x L x 0.746 kW/hp x hrs x (100/Estd- 100/Eee)
Annual Cost Savings, \$/yr = Kwh/yr saved x utility rate

hp = rated motor horsepower
L = load factor as decimal
Estd = % efficiency standard motor
Eee = % efficiency energy efficient motor
hrs =Annual operating hours

$$\text{Simple Payback (Years)} = \frac{\text{initial cost}}{\text{Annual cost savings}}$$

Below is a comparison between some common standard efficiency motors and energy efficient motors. As you can see, it does not take long to pay back the higher initial cost of an energy efficient motor, and begin saving money and energy.

COMPARISONS BETWEEN STANDARD-EFFICIENCY (SE) MOTORS AND ENERGY-EFFICIENT (EE) MOTORS

Motor (hp)	Purchase Cost ($)			Efficiency (%)		Annual Savings		Simple Payback (years)
	SE	EE	Difference	SE	EE	kWh	$	
10[a]	614	795	181	86.5	91.6	2103	210	0.86
25[a]	1230	1608	378	88.1	94.2	6004	600	0.63
50[a]	2487	3207	720	90.6	95.0	8352	835	0.86
100[a]	5756	7140	1384	90.7	95.7	18,822	1882	0.74
200[b]	11,572	13,369	1797	94.6	96.1	10,782	1078	1.67
300[b]	15,126	18,385	3259	94.6	96.0	15,111	1511	2.16

Note: Based on 16 hr/day operation at 75% load and $0.10/kWh
[a] Reliance Standard-Efficiency and Premium-Efficiency Motors
[b] G.E. EnergySaver and Standard-Efficiency Motors

The above table ignores other potential benefits of energy efficient motors. A lower priced premium motor, a rebate program or increased reliability can make energy efficient motors even more cost effective. An evaluation of motor efficiency is usually combined with a **pumping system evaluation.**

Should I Rewind Existing Motor or Purchase New

Rewinding, or rebuilding, an electric motor involves replacing the internal components. Although failed motors can usually be rewound, it is often worthwhile to replace damaged motors with new energy efficient models to save energy, money and improve reliability. Here are a few rules of thumb to consider when deciding whether to rewind a motor or purchase a new one:

- Replace an existing premium motor if the repair cost is more than 60% of the cost of a new one.

- Intermittent or low usage- Use the lowest cost option that meets your operating requirements.

- Single shift operation, 2000 hrs/yr- Replace all low efficiency motors below 30 hp with premium efficiency motors. Consider repairing motors above 30 hp.

- Two shifts, 4000 hrs/yr- Replace all low efficiency motors below 100 hp with premium efficiency motors. Consider repairing motors above 100 hp.

- For continuous operation, 8760 hrs- Replace all low efficiency motors with premium efficiency motors.

When calculating the operating costs for rewound motors, deduct one efficiency percentage point for motors larger than forty horsepower and two points for smaller motors. As an example, a one point gain of motor efficiency for a twenty-five horsepower motor saves about $136/ year, or $ 2040 over its lifetime (based on $0.10/kWh, 75% load, and 15 year life).   U.S. Department of Energy's MotorMaster software can help you compare efficiencies of like models and select the most appropriate motor for your application.

Variable Frequency Drives

A variable frequency drive (VFD) is an electronic controller that adjusts the speed of an electric motor.   Most industrial AC (alternating current) induction motors manufactured in the US are designed to operate with a current that alternates in the direction of flow 60 times per second (HZ). If this frequency of alternation is changed, the speed of the motor changes. By controlling the AC frequency and voltage with a variable frequency drive, you control motor speed.   Therefore, VFDs can provide continuous control, matching motor speed to the specific demands of the work being performed.   Standard motor starters start motors abruptly, subjecting the motor to high torque and current surges up to 10 times the full-load current. In contrast, VFDs offer a "soft start" capability, gradually ramping up a motor to operating speed. This lessens mechanical and electrical stress on the motor system, reduces maintenance and repair costs, and extends motor life.

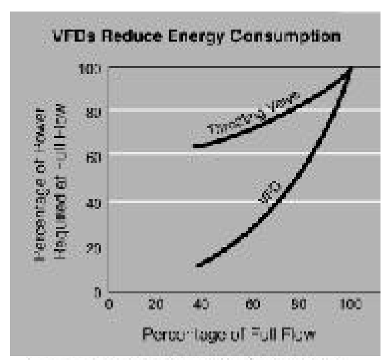


Figure 1. Energy consumption of VFDs and throttling valves.

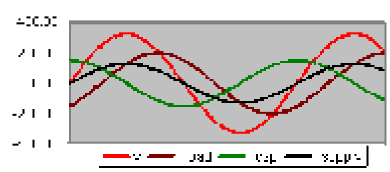
VFDs are increasing in popularity at wastewater facilities where the greatest energy use is from pumping and aeration- two applications particularly suited to VFDs. For applications where flow requirements vary, mechanical devices such as flow-restricting valves or moveable air vanes are often used to control flow. This is akin to driving a car at full throttle while using the brake to control speed. This process uses excessive energy and may create punishing conditions for the mechanical equipment involved.   VFDs enable pumps to accommodate fluctuating demand, running pumps at lower speeds and drawing less energy while still meeting pumping needs. Figure 1 illustrates the reduced energy consumption of VFDs over valve control systems. With VFDs, wastewater treatment plants can more consistently maintain desired dissolved oxygen (DO) concentrations over a wide range of flow and biological loading conditions by using automated controls to link DO sensors to VFDs on the aeration blowers.

Energy savings from VFDs can be significant. Even a small reduction in motor speed will significantly increase your energy savings. For example, a 20% reduction in motor speed can reduce the energy requirements by nearly 50%. Therefore, a pump motor that does not usually need to run at full speed can substantially reduce its energy use by using a VFD. For example, a 25-hp motor running 23 hours per day (2 hours at 100% speed; 8 hours at 75%; 8 hours at 67%; and 5 hours at 50%) can reduce energy use by 45% using a VFD. At $0.10 kWh, this saves $5,374 annually. VFDs work with most three-phase electric motors, so existing pumps and blowers that use throttling devices can be retrofit with these controls. VFDs can also be specified for new equipment.

Initial costs for VFDs can seem expensive, but payback periods for these drives can range from just a few months to less than three years for 25 to 250 hp models. In addition, savings from reduced maintenance and longer equipment life contribute significantly to achieving a rapid payback and long-term savings. Also, many electric utilities offer financial incentives that can reduce the installed costs of VFDs.

VFDs are not suited to all applications, such as flow that is relatively constant. Therefore it is important to calculate the benefits for each application based on the system variables such as pump size, variability of flow, and total head. As mentioned, it is prudent to first perform a pumping system assessment to determine if flow and energy requirements in the pumping system can be reduced before making other energy improvements.

Power Factor Correction



As with any equipment, an electrical system handles its job to some degree of efficiency ranging from poor to excellent. This measure of electrical efficiency is known as the Power Factor. Under ideal conditions the power factor would be 100%. However, motors and other inductive equipment (transformers, light ballasts) require energy that does no work and as a consequence, the power factor decreases.

Low power factor causes heavier currents to flow in distribution lines in order to provide needed kilowatts to the end user. Because the utility company must invest in oversized equipment to provide increased power to serve low power factor loads, a charge is commonly assessed on a facility's electric bill to recover the equipment costs and lost energy caused by low power factor. The direct cost of a low power factor usually shows up on the monthly bill as an extra charge. The assessed charges are not always readily obvious by looking at your bill. Some of the more common names for the charges are: power factor penalty, pf adjustments, or kVA demand, to name a few. Analyzing your utility bills will usually reveal if you have a power factor problem. Even if the utility does not bill directly for power factor, a low power factor can raise your kWh and demand billing. All utility companies can supply you with a rate schedule that explains their charges including power factor.

Many facilities can improve their power factor by ensuring their motors are not oversized and by installing power factor correction capacitors **(see Appendix C)**. However, the cost effectiveness of improving power factor depends on such variables as utility power factor penalties, the facility's need for additional electrical system capacity, and energy costs. The following example will give you an idea of the penalty for having a low power factor.

> A facility has an average monthly demand of 1200 kW and a power factor of 0.78. The utility charges according to kW demand (say $4.50/kW) and has a surcharge for power factors less than 0.95. The following formula shows a billing adjustment based upon a power factor less than 0.95.
>
> kW (billed) = kW demand x demand rate x 0.95/PF
>
> Monthly Utility bill with present power factor of 0.78:
>
> kW (billed) = 1200 kW x $4.50 x 0.95/0.78 = $6579
>
> Monthly Utility bill after power factor corrected to 0.95:
>
> kW (billed) = 1200 kW x $4.50 x 0.95/0.95 = $5400
>
> Annual Savings=($6579 - $5400) x 12 months=$14,148

In this example, if the organization supports cost saving projects with a payback of 3 years or less, then power factor correction equipment costing less than $42,000 would make this project acceptable, and profitable.

As you can see, to assess the benefits of installing equipment to correct your power factor it is critical to understand your electric bill and the utility's rate structure. Your utility can provide you with printed rate schedules that describe the various rates available and illustrate how charges are calculated. **Appendix B** explains further about understanding your utility bill. **Appendix C** provides some examples of managing energy use and improving power factor.

Lighting

Lighting is often overlooked for energy saving opportunities at treatment facilities because it is overshadowed by the energy use of motor and pumps. At other types of facilities (schools, police stations, office building) lighting is a major energy consumer and is one of the first areas evaluated to improve efficiency and reduce costs. For example, the increased cooling demand generated by inefficient lighting systems can add 10% to cooling energy costs. Many businesses are lowering their lighting and cooling bills by installing energy-efficient equipment. Likewise, municipal treatment facilities should also take full advantage of advances in lighting technology to reduce both the energy costs and the higher maintenance of older lighting systems.

Lighting technology and design have had many new developments in recent years. Technology improvements have increased lamp efficiency, improved color rendering and extended lamp life. New electronic ballasts enable fluorescent lamps to operate flicker-free, last longer, start faster and operate cooler. In addition, some ballasts provide smooth and silent dimming. Improvements in lighting fixtures offer better reflection of light and can reduce the number of bulbs needed. There have also been many developments in electronic controls for lighting, either daylight-linked or occupancy-linked. The payback for the costs of a lighting upgrade is typically between 1 and 3 years. Here is a simple example.

Existing Lighting system:

4- 40 watt T 12 fluorescent lamps (1.5 inch diameter by 4 feet)
2- 16 watt magnetic ballast
Time used: 3000 hours per year
Annual Cost: (192 watts x 3000 hrs) x 1 kW/1000watts x $0.10/ kW
Annual Cost = $ 57.60

Replacement Lighting system:

2- 32 watt T 8 fluorescent lamps (1 inch diameter by 4 feet)
1- 2 watt electronic ballast
1 - new Reflector Fixture
Annual Electric Cost = $ 19.80
Capital Cost for New Equipment = $65.00

$$\text{Payback: } \frac{\text{Capital Cost}}{\text{Annual savings}} = \frac{\$\ 65.00}{\$\ 57.60 - \$\ 19.80} = 1.7 \text{ years}$$

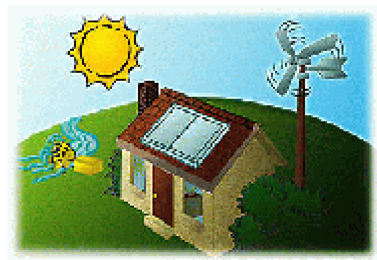
The above example shows the benefits of changing a lighting fixture which is working. For fixtures which are in disrepair (blown, darkened, or discolored bulbs, or defective ballasts), replacing them with an energy efficient system is the only practical way to go. The above example is also only for one lighting fixture. Even small facilities will have many of these fixtures throughout a building. In this example, after 1.7 years the facility starts saving $ 37 per fixture per year.

Exit lights can also waste energy. Typical older exit lights have two 15 or 20 watt incandescent lamps. The new exit lights have either one 7 watt fluorescent lamp or two ½ watt Light Emitting Diodes (LED). Exit lights are on all the time (8760 hours per year). Two 15 watt lamps at $0.10

per kilowatt-hour will use more than $25 per year in power. An LED retrofit kit only costs about $25. Converting older style exit lights to LEDs will pay for themselves in about a year, and thereafter cost almost nothing to operate. Also, LEDs can last up to twenty five years.

Becoming aware of today's efficient lamps, ballasts, reflective fixtures, and control options available is the first step toward reducing your lighting costs. **Appendix E** explains these technologies further.

Clean Renewable Energy Sources



As the world population continues to grow, so does our need for energy, and all power sources impact the natural environment in one way or another. Some are sources of air pollution, others present waste, water or land issues. Currently, most of our energy is from fossil fuels (coal, oil, natural gas), which are limited, non-renewable and create air pollution. For the most part, renewable energy (sun, wind, water, biomass, geothermal) is produced without a large amount of air emissions and are virtually inexhaustible. However, the construction and maintenance of both renewable and non-renewable power plants may impact land, water and the surrounding environment.

Restructuring of the electric utility industry gives consumers the choice of who generates their electricity. Renewable energy typically costs more to produce, but with more consumer support, the costs of renewable power should go down. You can affect the availability and affordability of renewable energy by choosing an energy supplier who is more environmentally responsible.

Net Metering

Net metering programs allow the electric meters of customers with generating facilities to turn backwards when their generators are producing more energy than the customers' demand. Net metering allows customers to use their generation to offset their consumption over the entire billing period, not just instantaneously. This offset would enable customers with generating facilities to receive retail prices for more of the electricity they generate. Net metering is a simple and low-cost method to encourage direct customer investment in renewable energy technologies. The renewable energy industry supports net metering because it removes an economic disincentive for potential customers by increasing the value of the electricity generated by renewable energy technologies. Environmental groups support net metering because it promotes clean energy production.

Although generating electricity onsite from a renewable source is generally higher than for fossil fuels, when coupled with financing opportunities such as grants, discounts, and low interest loans, these sources can be affordable. Below are descriptions of some renewable and less polluting energy sources and possible uses at wastewater treatment facilities. For more information on energy efficiency and renewable energy contact the Department of Energy at www.eren.doe.gov, or, http://erecbbs.nciinc.com .

Wind

Early windmills of the 1800s produced mechanical energy to pump water or run saw mills. Today, wind energy may be used to generate electricity directly, power mechanical systems, or reduce a facility's energy costs when sold to a utility. Many utilities, such as Green Mountain Power Service in Vermont, have windfarms to generate electricity. Wind energy is currently cost effective for electricity generation only where the annual average wind speed is at least 12 mph. However, many municipal wastewater treatment facilities are located in a windy areas, such as a valley, the coastline, where wind may be a potential energy source.

For lagoon treatment systems that use surface aerators, it is possible to use the wind to directly power mechanical surface aerators to relieve existing aerators powered by the utility. The minimum wind speed for these systems is only 4 mph. The New Hampshire Department of Environmental Services (DES) is working with a community to demonstrate the effectiveness of wind powered surface mechanical aerators in a wastewater stabilization pond to save energy. The project is partially funded by a grant from the Governor's Office of Energy and Community Service. It began during the summer of 2000 and expects to last two years.

An alternative to using the wind to directly power a facility is to sell the wind generated energy to your utility to defray energy costs and continue to use the utility's power to operate the facility.

Solar

A variety of technologies have been developed to take advantage of solar energy (energy from the sun). Two major technologies are solar heating and cooling of buildings and photovoltaic conversion (converting sunlight into electricity).

Solar Heating and Cooling

Facilities that have good southernly exposures can take advantage of the suns energy. There are a few examples of wastewater facilities in New England using solar energy for heating.

One facility in New Hampshire uses a *solar wall* to help with its heating needs. The solar wall is based on simple passive solar heating principles. The system works by heating air with a south-facing solar collector—a dark-colored wall made with an energy absorbing material. As the sun strikes the collector hot air begins rising in the space between the solar wall. The heated air vents through the top of the wall and is distributed into the building. As heated air vents from the top of the wall, the cooler room air returns to the collector through vents near the bottom. The temperature is regulated by a thermostat which controls the vents at the top of the wall. Any additional heating needed at night or on cloudy days is supplied by the building's conventional heating system. During summer months, the sun is reflected off the collectors to prevent overheating.

A solar wall can be designed as an integral part of a new building or it can be added in a retrofit project. Expenses are usually minimal, because a solar collector requires little mechanical equipment.

Photovoltaic

Photovoltaic (PV) systems presents many possibilities and are the most versatile. PV systems became popular through the space program and are the primary source of power for satellites. PV cells have no moving parts, are easy to install, require little maintenance, do not emit air pollutants, and have a life span of up to twenty years. Because PV systems only work when the sun is shining, most systems are used in combination with batteries. Although the capital cost of PV systems has come down substantially, it is still high, and, except in certain circumstances, is not competitive with conventional grid power. Some instances where PV can be the better choice of power are:

> * Power line extensions, even for short distances, will not be cost-effective considering the low loads to be carried;
>
> * The remote location makes the costs or difficulty of transporting and storing diesel fuel prohibitive;
>
> * Electrical needs are small, seasonal or remote.

Other industries have found applications where solar energy makes economic sense, such as, operating pumps for irrigation, air and water heating, and outdoor security lighting. Some of these application may also have possible uses at wastewater facilities. Some state agencies and utilities provide financial assistance for renewable energy projects.

Effluent Hydropower

Flowing water creates energy, which can be captured and turned into electricity. This is called hydropower. The energy of falling water is converted to mechanical energy by means of a turbine. The most common type of hydropower plant uses a dam on a river to store water in a reservoir. Water released from the reservoir flows through a turbine, spinning it, which in turn spins a generator which produce electricity. In the case of a wastewater treatment facility, the effluent is the flowing water. The energy produced depends on the distance the wastewater falls and the flow rate of the wastewater. The larger the flow and the further the wastewater falls, the more cost effective the system. In the late 1970s and early 1980s, two wastewater facilities in

New England operated an effluent driven turbine, each with limited success. In **Appendix F**, the effluent driven turbine that was used at the Montague, Massachusetts wastewater treatment facility is briefly discussed. Although each facility is distinct, you can use the following formula to calculate the potential energy from an effluent driven turbine.

Potential Power (kW)= Head (feet) x flow(gpm) x 0.18(efficiency)
kWhr/yr = Power x 8760 hrs/yr

As with a wind system, power generated with an effluent driven turbine can be used directly or sold back to a utility. Your utility or state energy office may assist with financing or technical assistance for such a project.

Micro turbines

Micro turbines are adaptable low emission power generation systems. A natural gas turbine driven generator, coupled with an electronic control module, allows the unit to operate alone or connected to the grid. It produces electricity efficiently while emitting very low levels of air pollutants. They are low maintenance, can operate using a variety of fuels, and produces a clean oxygen rich heat exhaust that may be used as a heat source for the facility. **Appendix F** includes a preliminary evaluation of the application of a micro turbine at the Veazie, Maine wastewater treatment facility. For many facilities, the supply and cost of natural gas is critical to the cost evaluation. However, there are now several gas pipelines in New England, making gas supply more accessible. In the Veazie case, a pipeline is currently being constructed nearby, which presents the possibility of the wastewater treatment facility tying into the pipeline.

If your facility is evaluating options for future biosolids disposal, you may want to consider anaerobic digesters. The methane gas produced from digesters has long been valued as a fuel source at wastewater treatment facilities for heating and generating electricity. Similarly, landfills are a source of methane production that can be used as fuel. For further information about microturbines contact www.capstone.com.

Summary

Efficiency in motors, drives, lighting and other energy consuming technologies have come a long way in recent years. Older facilities that have not yet experienced an upgrade can definitely benefit from the newer technology. For motors operating more than 2000 hours per year, it makes sense to use only the most efficient motors available, because the cost of power in the Northeast outweighs the cost of a motor. If flow rates have changed over time your facility could benefit from a pumping system evaluation. Energy use in New England clearly has an